

Amended English Specification with Abstract

**METHOD FOR CONTROLLING AN IMAGING BEAM PATH WHICH IS
TAPPED OFF FROM A FILM RECORDING BEAM PATH OF A MOVIE
CAMERA**

CROSS-REFERENCE TO A RELATED APPLICATION

5 This application is a National Phase Patent Application
of International Patent Application Number
PCT/DE2005/000498, filed on March 15, 2005, which
claims priority of German Patent Application
10 Number 10 2004 016 224.7, filed on March 26, 2004.

BACKGROUND

15 The invention relates to a method for controlling an
imaging beam path, which is tapped off from a film
recording beam path of a movie camera and to an
apparatus for carrying out the method.

20 DE 27 34 792 C2 discloses a viewfinder system for a
movie camera having a rotating mirror shutter which is
synchronized to the transport speed of a movie film,
periodically interrupts the recording beam path, which
runs from a recording objective of the movie camera to
the film plane and branches off into a viewfinder beam
25 path, such that an image of the scene to be recorded is
either alternately projected onto a movie film in an
exposure phase, or is diffracted from the rotating
mirror shutter into the viewfinder beam path in an
exposure pause. An image plane is located in the
30 viewfinder beam path at the same distance from the
reflective surface of the rotating mirror shutter as
the film plane, on which image plane the viewfinder
image is imaged in the exposure pause by transmission

optics as a real image on the plane of an image field shutter, and can be viewed through an eyepiece.

5 In order to allow the contrast scope of a recorded image to be assessed better and to allow scattered light as well as reflected light to be identified more easily, it is known from pages 42 and 43 of the operating instructions for the ARRIFLEX 535 movie camera for a movie camera to be equipped with contrast
10 filters which can be pivoted by means of a lever into the viewfinder beam path of a movie camera, thus making it possible to vary the quality of the viewing of the recorded image in steps.

15 JP 10010633 A discloses a viewfinder arrangement for a still-image camera, in which a DMD (Digital Micromirror Device) chip is arranged in the viewfinder beam path and has a large number of two-dimensionally arranged micromirror elements, which comprise micromirrors which
20 are articulated such that they can move and digitally vary the deflection angle when a voltage is applied, that is to say can be pivoted between two different alignments of the mirror surface. The DMD chip, which is arranged in the viewfinder beam path, is driven by a
25 DMD driver circuit and places either the recorded beams received via an objective or the information emitted from a display in the viewfinder beam path, so that it is possible to view either an object to be recorded or the display information using the viewfinder. The
30 display and the driver circuit which drives the DMD chip are driven by a common CPU.

This known viewfinder system is, however, not suitable for overlaying format indications on the viewfinder
35 image of a movie camera or for superimposing or simultaneous overlaying of recording-specific or camera-specific data in a viewfinder image together with the viewfinder beam path, which is tapped from a

recording beam path, since the display information which is overlaid in the viewfinder beam path is input from the display, but is not governed by the position or deflection of the micromirrors.

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It is also known for DMD chips to be driven with a changing frequency, so that the gray-scale levels for the light transmission by means of the DMD chip can be varied as a function of the ratio of the switched-on
10 times to the switched-off times, that is to say a brighter gray-scale level is transmitted when the switched-on times are long in comparison to the switched-off times, while darker gray-scale levels are transmitted if the switched-off times are increased in
15 comparison to the switched-on times.

A further problem in the operation of movie cameras is that there is a risk of the introduction of stray light via the eyepiece and the viewfinder beam path into the
20 movie camera and thus into the recording beam path, resulting in undesirable exposure of the movie film, when, for example, the eyepiece is not covered by the cameraman's eye. In order to prevent such inadvertent exposure of the movie film by means of stray light,
25 complex measures are required, which consume space.

SUMMARY

One object of the present invention is to specify a
30 method of the type mentioned in the introduction, by means of which the contrast of the viewfinder image can be infinitely variable, and which ensures that no stray light can reach the movie film even when the viewfinder eyepiece is not covered.

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The solution according to the invention allows continuously variable adjustment of the image brightness and/or of the image contrast of a viewfinder

image, and prevents stray light from reaching the movie film in a movie camera via the viewfinder beam path, irrespective of whether the viewfinder is covered.

5 In particular, the solution according to the invention makes it possible to use the optical capabilities of an optical switching element in the form of a DMD chip in order to view the image through the viewfinder of a movie camera, in that it controls the amount of light
10 which is deflected into the eyepiece of a movie camera from the viewfinder beam path during pauses in the exposure of the movie film, and thus allows both better assessment of the amount of contrast in the recorded image, as well as making it easy to identify stray
15 light and light reflections. Furthermore, if the optical switching element is driven such that it is synchronized to the image recording sequence of the movie camera, this makes it possible to prevent stray light from entering the movie camera, and thus from
20 reaching the movie film, via the viewfinder beam path.

Variation of the duty ratio of the deflection of the imaging beam path to the various imaging planes makes it possible not only to infinitely variably adjust the
25 contrast for image viewing through the viewfinder of the movie camera, but also to tap off an additional video beam path for viewing and recording of the recorded image on a video monitor or video recorder, and to control the amount of light which is tapped off
30 into the video beam path.

In particular, the duty ratio for the deflection of the imaging beam path is varied by pulse-width-modulated control of the optical switching element.

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The imaging beam path may either be deflected as the viewfinder beam path of the movie camera onto an image plane which can be viewed through an eyepiece, or into

a light trap, as a video beam path of the movie camera to an optoelectronic transducer for conversion of the video beam path to video signals, or into a light trap and both into a viewfinder beam path with an image
5 plane, which can be viewed through an eyepiece, and into a video beam path with an optoelectronic transducer for conversion of the video beam path to video signals from the movie camera, or into a light trap.

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In order to prevent exposure of the movie film by stray light when the eye has been removed from the viewfinder of the movie camera or the viewfinder is not covered, the imaging beam path is either interrupted in
15 synchronism with the exposure phase of the movie film, or is deflected from the image plane to be viewed through the eyepiece into the light trap. In addition to the infinitely variably adjustable contrast filter, this provides an electronic closure in the viewfinder
20 beam path of a movie camera, which effectively prevents inadvertent exposure of the movie film by light which enters the cameras interior via the viewfinder beam path.

25 An apparatus for carrying out the method is characterized by at least one DMD (Digital Micromirror Device) chip which is arranged in the imaging beam path of the movie camera and has a large number of micromirrors which are arranged in the form of a
30 raster, can be pivoted under electronic control, and deflect the incident beam path to a first or a second imaging plane, or into a light trap.

The apparatus according to the invention results in an
35 optical switching element which is in the form of a DMD chip being used as an infinitely variable contrast filter and stray-light filter. Furthermore, the DMD chip may be used as an optical switching element to

prevent stray light from entering the recording beam path, and to control the amount of light which is input into a viewfinder beam path and/or into a video beam path of a movie camera.

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These functions are carried out in such a way that the micromirrors of a first DMD chip reflect the imaging beam path alternately to imaging optics in a viewfinder beam path, or into a beam path of a first light trap, and/or the micromirrors of a second DMD chip deflect the imaging beam path alternately to a video beam path with an optoelectronic transducer for conversion of the video beam path to video signals, or into a beam path of a second light trap.

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In one embodiment, the imaging beam path is split via a beam splitter into a viewfinder beam path and a video beam path, the micromirrors of the first DMD chip, which is arranged in the viewfinder beam path, reflecting the imaging beam path to the imaging optics in the viewfinder beam path with an image plane which can be viewed through an eyepiece, or into the beam path of the first light trap, and the micromirrors of the second DMD chip deflecting the imaging beam path to the video beam path with an optoelectronic transducer for conversion of the video beam path to video signals, or into the beam path of the second light trap.

Alternatively, the beam splitter can be arranged between the first DMD chip and the viewfinder eyepiece, and can split the imaging beam path into a viewfinder beam path and a video beam path, with the micromirrors of the first DMD chip for light control alternately reflecting the imaging beam path to the beam splitter or into the beam path of the first light trap.

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In this embodiment variant, the micromirrors of a second DMD chip for light control can deflect the video

beam path to an optoelectronic transducer for conversion of the video beam path to video signals, or into a beam path of a second light trap.

5 The DMD chip or chips is or are preferably driven via a driver circuit which is connected to a control circuit for the movie camera and for the video output mirror or mirrors. This not only makes it possible to control the amounts of light which are input into the viewfinder
10 beam path or into the video beam path, but also to control the synchronization with the image recording frequency of the movie camera and/or the video frequency of the video output mirror device.

15 **BRIEF DESCRIPTION OF THE DRAWINGS**

Further features of the invention and of the advantages which can be achieved by the solution according to the invention will be explained with reference to exemplary
20 embodiments, which are illustrated in the figures, in which:

FIG. 1 shows a schematic illustration of a film recording and imaging beam path of a movie
25 camera with a DMD chip for deflection of the imaging beam path into the viewfinder beam path of the movie camera, or into a light trap.

FIG. 2 shows a schematic illustration of a film recording and imaging beam path of a movie
30 camera with a beam splitter for deflection of the imaging beam path into a viewfinder beam path, and a video beam path, each having a DMD chip for light control.

35 FIG. 3 shows a schematic illustration of a film recording and imaging beam path of a movie camera with a DMD chip for light control, and

with a beam splitter for deflection of the imaging beam path into a viewfinder beam path and a video beam path.

5 DETAILED DESCRIPTION

FIG. 1 uses schematic outlines to show a movie camera 1 with a rotating mirror shutter 3, which passes a recording beam path S1 which is passed via a camera
10 objective 2, to a movie film 10, which moves on a film plane behind an image window 4, for film image exposure during an exposure phase, or periodically deflected into an imaging beam path S2. A fiber panel or a matt
15 disk 5 which, for example, is in the form of a planar-convex lens, is arranged in the imaging beam path S2 and is located on the image plane, that is to say at the same distance from the rotating mirror shutter 3, as the film plane, on which the movie film 10 is transported intermittently.

20 The recorded image which is imaged on the matt disk or fiber panel 5 in the exposure pauses of the movie film 10 is deflected by means of a DMD chip 6 either into a viewfinder beam path S3 or into a beam path S4 which
25 leads to a light trap 13. The DMD chip 6 has a large number of tilting micromirrors, which are arranged in the form of a raster or matrix and can be driven quickly by means of a driver circuit 15, on a semiconductor substrate, which mirrors are pivoted,
30 depending on the drive, by the driver circuit 15 between two mirror positions, which include an angle of, for example, 10 to 12 degrees. Because the micromirrors of the DMD chip 6 are arranged in the form of a raster or matrix, each micromirror corresponds to
35 one image pixel, so that an image code which is supplied to the DMD chip 6 from the driver circuit 15 in order to drive the micromirrors initiates each individual micromirror, and accordingly leaves it in

the rest position, or deflects it to a deflected position.

On the input side, the driver circuit 15 is connected to a control circuit 16, which is connected to an input keyboard, camera or image recording sensors, or part of a microprocessor of the movie camera 1 in order to control the camera functions and processing of input data or data recorded by sensors.

The viewfinder eyepiece 8 contains an adjusting disk 81 in the form of a matt disk or fiber panel, where a viewfinder image is imaged, and can be viewed by a cameraman's eye 12 via viewfinder optics 82.

The input field of the movie camera 1 contains a nominal-value transmitter or a control element, by means of which the time duration of the deflection of the imaging beam path S2 into the viewfinder beam path level S3 during the exposure phase of the movie film 10, and thus the amount of light input into the viewfinder beam path S3, can be adjusted. This allows the cameraman to mask out stray-light influences and light reflections in the recorded image and, in particular, to optimize the contrast range in the recorded image, in which case the continuously variable adjustment of the control element is associated with continuously variable variation of the duty ratio of the micromirrors of the DMD chip 6, by means of which the micromirrors are pivoted between the viewfinder beam path S3 and the beam path S4 of the light trap 13.

The driver circuit 15 drives the DMD chip 6 in such a manner that, during the image exposure pause, the micromirrors of the DMD chip 6 are pivoted backward and forward at high frequency between the viewfinder beam path S3 and the beam path S4 of the light trap 13, and the amount of light, which is input into the viewfinder

beam path S3 on the one hand and into the beam path S4 of the light trap 13 on the other hand, in the imaging beam path S2 is varied infinitely variably by variation of the duty ratio, by means of pulse-width modulation.

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In order to prevent the movie image 10 from being exposed by stray light when the eye 12 has been removed from the eyepiece 8 or the viewfinder eyepiece 8 is not covered, the DMD chip 6 is driven via the driver circuit 15 by the control circuit 16 such that the viewfinder beam path S3 is interrupted synchronously during the exposure phase of the movie film 10, so that, during the exposure phase of the movie film 10, the micromirrors of the DMD chip 6 deflect the imaging beam path S2 into the beam path S4 of the light trap 13, and thus mask out the light beams entering the movie camera 1 from the viewfinder optics 8.

The arrangement shown in FIG. 1 may analogously have a video output mirror device 9 as shown in FIG. 2 added to it, whose object and function will be explained in more detail in the following text.

In a corresponding manner to the schematic illustration of a film recording beam path and imaging beam path shown in FIG. 1, FIG. 2 shows a movie camera 1 with a rotating mirror shutter 3, which passes on the recording beam path S1, which passes via a camera objective 2, either to a movie film 10, which moves on a film plane behind an image window 4, for film image exposure, or deflects it to an imaging beam path S2. A matt disk 5, on which a recorded image is imaged during the exposure pauses of the movie film 10, as well as a beam splitter 13 are arranged in the imaging beam path S2, with the beam splitter 13 splitting the imaging beam path S2 into a viewfinder beam path S3, and a video beam path S5.

The viewfinder beam path S3 is deflected by means of a first DMD chip 6, which is arranged in the viewfinder beam path S3, either into a viewfinder eyepiece 8 or into a beam path S4, which leads to a first light trap 13.

The first DMD chip 6 has a large number of micromirrors which can be driven at high speed and are arranged in the form of a raster or matrix, and which are pivoted between two limit positions, which include an angle of, for example, 10 to 12 degrees.

The viewfinder eyepiece 8 contains an adjusting disk 81 in the form of a matt disk or fiber panel, where a viewfinder image is imaged and can be viewed via viewfinder optics 82 by a cameraman's eye 12.

A second DMD chip 7 is arranged in the video beam path S5, which is split off from the imaging beam path S2, and likewise has a large number of micromirrors which can be driven quickly and are arranged in the form of a raster or matrix, and are pivoted between two limit positions which include an angle of, for example, 10 to 12 degrees, and which deflects the video beam path S5 either to a video output mirror device 9 or as the beam path S6 to a second light trap 14.

The video output mirror device 9 contains video optics 91, a video sensor 92 which converts the optical image from the beam path S5 to image signals, and video electronics 93, which produce video signals from the image signals and emit them, possibly together with further control signals and data, to a personal computer, as well as receiving data and control signals from the personal computer. Since the video beam path S5 which is deflected from the imaging beam path S2 by means of the beam splitter 11 is passed via the second DMD chip 7, the recorded image is laterally inverted in

the beam path to the video output mirror device 9, so that electronic mirroring is carried out in the video output mirror device 9, in order to reproduce the image correctly.

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The video electronics 93 offer the capability for connection of a monitor 94, on which the video images formed from the video signals can be viewed directly on the movie camera 1.

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Depending on the angular position of the rotating mirror shutter 3, the recording beam path S1 strikes the opening sector (bright sector) of the rotating mirror shutter 3, and passes through the image window 4 to the movie film 10, which is guided in the film channel, there, during transportation of the movie film 10, the image window 4 is covered by the mirror surface of the rotating mirror shutter 3, and the recording beam path S1 is deflected as the imaging beam path S2 onto the matt disk or fiber panel 5, from where the imaging beam path S2 is split via the beam splitter 11 into the viewfinder beam path S3 and the video beam path S5. The viewfinder beam path S3, which falls on the first DMD chip 6, is deflected via its micromirror either to the viewfinder eyepiece 8 or as the beam path S4 to the first light trap 13.

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The video beam path S5, which is derived from the beam splitter 11, falls on the second DMD chip 7, which deflects it either to the video output mirror device 9 or as the beam path S6 to the second light trap 14. As a result of the periodic interruption in the recording beam path S1, the video output mirror device 9 has predetermined for it not only a mode select signal, which presets a desired exposure mode, but also a shutter index signal by the movie camera, which corresponds to the respective exposure conditions for

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the video beam path S5 and thus the exposure conditions on the video sensor 92.

FIG. 3 shows an alternative embodiment in which the
5 beam splitter 11 is arranged between the first DMD chip
6 and the adjusting disk 81 for the viewfinder eyepiece
8, so that the imaging beam path S2 is either reflected
into the combined viewfinder and video beam path S3 and
S5, respectively, or to the first light trap 13. The
10 amount of light which is deflected into the viewfinder
and video beam path S3 or S5, respectively, is in this
embodiment the same and depends on the division ratio
of the beam splitter 11, which may also be provided
with different reflection areas or pass areas, thus
15 ensuring that the image is viewed in a suitable manner
through the eyepiece 8 and video output mirror system.

In this embodiment, either the second DMD chip 7 may be
omitted, so that the video beam path corresponds to the
20 viewfinder beam path, or a second DMD chip 7 is
provided in conjunction with a second light trap 14, as
in the embodiment shown in FIG. 2.